JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

Year & Sem. – B. Tech I year, Sem.-I
Subject –Engineering Chemistry
Unit – I
Presented by – Dr. Barkha Shrivastava
Designation - Associate Professor
Department - Chemistry

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1

VISSION OF INSTITUTE

To become a renowned centre of outcome based learning, and work towards   academic, professional, cultural and social enrichment of the lives of individuals and communities.

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2

MISSION OF INSTITUTE

❖Focus on evaluation of learning outcomes and motivate students to inculcate research aptitude by project based learning.

❖Identify, based on informed perception of Indian, regional and global needs, the areas of focus and provide platform to gain knowledge and solutions.

❖Offer opportunities for interaction between academia and industry.

❖Develop human potential to its fullest extent so that intellectually capable and imaginatively gifted leaders may emerge.

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3

Engineering Chemistry: Course Outcomes

Students will be able to:

CO1: Explain the impurities of water (mainly hardness) and boiler troubles.

CO2: Describe processing technologies of fuel with numerical aspects of combustion of fuel.

CO3: Describe the engineering material (cement, glass and lubricant) with respect to their manufacturing, composition, classification & properties.

CO4: Explain corrosion with its controlling measures, organic reaction mechanism and synthesis of drugs (Aspirin & Paracetamol) with their properties and uses.

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4

INTRODUCTION TO SYLLABUS

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5

JECRC
Department of Applied Sciences
Lecture Plan (Session- 2020-2021)

Course Name: Engineering Chemistry   **Year/Semester: 1st Year/ Semester- I**

Course code: 1FY2-03   **No. of Lecture Req. /(Avl.): /(40/44)**

Semester starting: 21 Sept. 2020   **Semester Ending: 24 Dec. 2020**

Unit No./ Total Lect. Req.	Topics	Lect. No.	Date of Delivery	Book Referred	Pg. No.
Unit-I 10	Introduction to syllabus, Common natural impurities, hardness, Degree of hardness,	1		Engg. Chemistry (New Age International)	2-12
	Units, of hardness, Determination of hardness by complexometric (EDTA method).	2			
	Municipal water supply, Requisite of drinking water, purification of water, Sedimentation,	3			
	Filtration, disinfection, Breakpoint chlorination.	4			
	Boiler troubles: Scale and Sludge formation, Internal treatment Methods	5			
	Priming and Foaming, Boiler corrosion and caustic embrittlement	6			
	Water softening: Lime-Soda process	7			
	Water softening: Zeolite (Permutit) process, Demineralization process.	8			
	Numerical problems based on Hardness, EDTA,	9			
	Numerical problems based on Lime-Soda and Zeolite process.	10			

Unit-II 10	**2.Organic Fuels: Solids fuels: Coal, Classification of Coal, Proximate analyses of coal and its significance**	**11**			
	Ultimate analyses of coal and its significance,	12			
	Gross and Net Calorific value, Determination of Calorific value of coal by Bomb Calorimeter.	13			
	Metallurgical coke, Carbonization processes; Otto-Hoffmann byproduct oven method.	14			
	Liquid fuels : Advantages of liquid fuels, Mining, Refining and Composition of petroleum, Cracking	15			
	Synthetic petrol, Reforming, Knocking, Octane number, Anti-knocking agents, Cetane number	16			
	Gaseous fuels; Advantages, manufacturing, composition and Calorific value of coal gas and oil gas	17			
	Determination of calorific value of gaseous fuels by Junker's calorimeter, Numerical problems based on Junkers calorimeter	18			
	Numerical problems based on determination of calorific value bomb calorimeter, /Dulongs formula, proximate & ultimate Analysis.	19			
	Numerical problems based on combustion of fuel.	20			

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7

Unit-III 3	**3.Corrosion and its control: Definition and significance of corrosion, Mechanism of chemical (dry) corrosion**	**21**			
	Mechanism of electrochemical (wet) corrosion, galvanic corrosion, concentration corrosion and pitting corrosion.	22			
	Protection from corrosion; protective coatings-galvanization and tinning, cathodic protection, sacrificial anode and modifications in design.	23			

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8

Unit-IV 10	4.Engineering Materials: Portland Cement; Definition, Manufacturing by Rotary kiln.	24			
	Chemistry of setting and hardening of cement. Role of Gypsum.	25			
	Glass: Definition, Manufacturing by tank furnace, significance of Annealing	26			
	Types and properties of soft glass, hard glass	27			
	Borosilicate glass, glass wool, safety glass.	28			
	Lubricants: Classification	29			
	Lubricants: Mechanism	30			
	Properties; Viscosity and viscosity index	31			
	Flash and fire point, cloud and pour point.	32			
	Emulsification and steam emulsion number.	33			

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9

Unit	Topic	No.			
Unit-V 7	**5. Organic reaction mechanism and introduction of drugs: Organic reaction mechanism: Substitution; SN1, SN2.**	34			
	Electrophilic aromatic substitution in benzene, free radical halogenations of alkanes,	35			
	Elimination: elimination in alkyl halides, dehydration of alcohols,	36			
	Addition: electrophilic and free radical addition in alkenes, nucleophilic addition in aldehyde and ketones	37			
	Rearrangement: Carbocation and free radical rearrangements	38			
	Drugs : Introduction, Synthesis, properties and uses of Aspirin	39			
	Drugs : Introduction, Synthesis, properties and uses of Paracetamol, Revision	40			

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10

Lecture-I (Unit-I Water)

- Common Natural Impurities of Water

- Hardness of Water

- Degree of Hardness

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11

Common Natural Impurities of Water

➢ ## Suspended Impurities

    1. Inorganic

    2. Organic

➢ ## Colloidal Impurities

    1. Inorganic

    2. Organic

➢ ## Dissolved Impurities

    1. Salts

    2. Gases

➢ ## Biological Impurities

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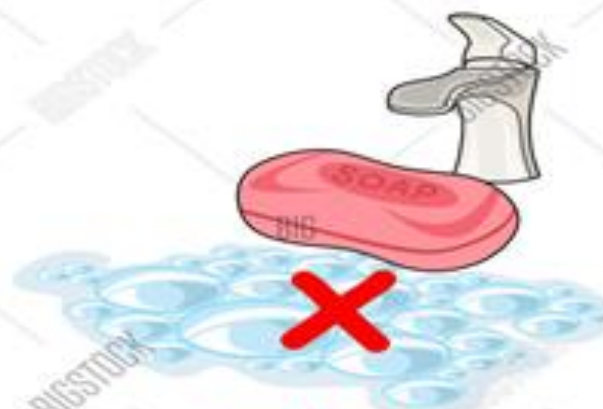
12

Hardness of Water:

Hardness of Water

Hard water is water in which some kind of salt $(Ca^{2+}, Mg^{2+}, Fe^{3+}, SO_4^{2-},$ and $HCO_3^-)$ has been dissolved.

Normal Water
Allows Lather Formation with Soap

Hard Water
Prevents Lather Formation with Soap

* Temporary Hardness: occurs due to presence of bicarbonate ion HCO_3^- in water and can be eliminated by boiling.

* Temporary Hardness: occurs due to presence of the ions Ca^{2+}, Mg^{2+}, Fe^{3+}, and SO_4^{2-} and cannot be eliminated by boiling.
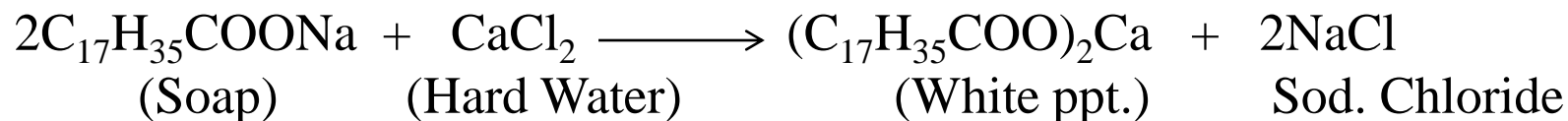
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13

Definition:

It is the characteristic property of water by virtues of this water does not form lather with soap solution.
Or
It is soap consuming capacity of water.

$$2C_{17}H_{35}COONa \ + \ CaCl_2 \longrightarrow (C_{17}H_{35}COO)_2Ca \ + \ 2NaCl$$

     (Soap)   (Hard Water)   (White ppt.)   Sod. Chloride

It is caused by 'DIVALENT METALLIC CATIONS' the principal hardness causing cations are calcium and magnesium there are two types of hardness temporary and permanent hardness

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14

Degree of Hardness/Measurement of Hardness:

The degree of hardness of water is conveniently expressed in terms of equivalent amount of $CaCO_3$.

Choice of $CaCO_3$ as the standard for reporting hardness of water is due to:

1. Its molecular weight which is exactly 100 and equivalent weight is 50 (easy for calculation)
2. It is the most insoluble salt , that can be precipitated in water treatment processes.

Thus equivalent of $CaCO_3$ for hardness producing substances can be calculated as:

$$\left[\frac{\left[\begin{array}{l}\text{Weight of hardness producing} \\ \text{substance (in mg/L)}\end{array}\right] \times \left[\begin{array}{l}\text{Chemical equivalent} \\ \text{of CaCO}_3 \ (i.e. 50)\end{array}\right] \times 2}{[\text{Chemical equivalent of hardness producing substance}] \times 2} \right] =$$

$$\frac{[\text{Weight of hardness producing substance (in mg/L)}] \times [100]}{[\text{Chemical equivalent of hardness producing substance}] \times 2}$$

or

$$\text{Multiplication Factor (in mg/L or ppm)} \times \text{Weight of hardness producing substance (in mg/L)}$$

$$\text{Multiplication Factor(M.F.)} = \frac{\text{Mol. weight of CaCO}_3}{2 \times \text{Chemical equivalent of hardness producing substance}}$$

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15

Multiplication Factors of Various Salts/Ions:

Dissolved salt/ion	Molar mass	Chemical equivalent	Multiplication factor for converting into equivalents of $CaCO_3$
$Ca(HCO_3)_2$	162	81	100/162
$Mg(HCO_3)_2$	146	73	100/146
$CaSO_4$	136	68	100/136
$CaCl_2$	111	55.5	100/111
$MgSO_4$	120	60	100/120
$MgCl_2$	95	47.5	100/95
$CaCO_3$	100	50	100/100
$MgCO_3$	84	42	100/84
$Mg(NO_3)_2$	148	74	100/148
Ca^{2+}	40	20	100/40
Mg^{2+}	24	12	100/24
HCO_3^-	61	61	$100/2\times61$
CO_3^{-2}	60	30	100/60
OH^-	17	17	$100/2\times17$
H^+	1	1	100/2
CO_2	44	22	100/44
HCl	36.5	36.5	$100/36.5\times2$
H_2SO_4	98	49	100/98
$FeSO_4.7H_2O$	278	139	100/278
$*AL_2(SO_4)_3$	342	57	$3\times\dfrac{100}{342}$ or $\dfrac{100}{114}$ or $\dfrac{50}{57}$
$**NaAlO_2$	82	82	$100/82\times2$

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16

How to calculate CaCO3 equivalents using multiplication factor

S.No.	Substances	Amount of Substances	Multiplication Factor	CaCO$_3$ Equivalent
1.	Mg(HCO$_3$)$_2$	16.8 mg/L	$\dfrac{100}{146}$	$\dfrac{100}{146} \times 16.8 = 11.50$ ppm
2.	MgCl$_2$	19 mg/L	$\dfrac{100}{95}$	$\dfrac{100}{95} \times 19 = 20$ ppm
3.	Mg(NO$_3$)$_2$	29.6 ppm	$\dfrac{100}{148}$	$\dfrac{100}{148} \times 29.6 = 20$ ppm
4.	CaCO$_3$	20 ppm	$\dfrac{100}{100}$	$\dfrac{100}{100} \times 20 = 20$ ppm
5.	MgSO$_4$	24 mg/L	$\dfrac{100}{120}$	$\dfrac{100}{120} \times 24 = 20$ ppm
6.	KOH	1.9 ppm	–	–

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17

Practice Questions

1. Hardness of water is due to the presence of salts of _____
a) Potassium
b) Chlorine
c) Magnesium
d) Boron

2. Select the incorrect statement from the following option.
a) Water which does not form lather with soap and forms white scum is called hard water
b) Hard water contains dissolved calcium and magnesium salts in it
c) In hard water, cleansing quality of soap is depressed
d) Due to the presence of dissolved hardness-producing salts, the boiling point of water is depressed

3. Select the incorrect statement from the following option.
a) Permanent hardness is due to dissolved chlorides and sulphates of calcium and magnesium
b) It can be removed by mere boiling of water
c) It is also known as non-alkaline hardness
d) The difference between the total hardness and the alkaline hardness

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18

Practice Questions contd…...

4. Alkaline hardness is due to the presence of bicarbonate, carbonate and hydroxides of the hardness-producing metal ions.
a) True
b) False
5. Select the incorrect statement from the following option.
a) The taste of hard water is better than soft water
b) The dissolved calcium in hard water can help to produce strong teeth
c) Hard water coats the lead piping with a layer of insoluble calcium carbonate which prevents poisonous lead dissolving in water
d) Boiler feed water should also be hard in nature
6. Hardness of water is conventionally expressed in terms of equivalent amount of _____
a) H_2CO_3
b) $MgCO_3$
c) $CaCO_3$
d) Na_2CO_3

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19

Practice Questions contd…...

7. The chemical equivalent of $MgSO_4$ salt is _____
a) 60
b) 47.5
c) 82
d) 68

8. How many grams of $MgCO_3$ dissolved per litre gives 84 ppm hardness?
a) 70.56 mg/L
b) 48.23 mg/L
c) 81.49mg/L
d) 66.12 mg/L

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20

Question Bank

Q1. Define Hardness of Water.

Q2. How many types of harness is there? Name them.

Q3. Which salts are responsible for permanent hardness in water?

Q4. Differentiate temporary and permanent hardness of water.

Q5. Define degree of hardness.

Q6. Give two reasons for choosing $CaCO_3$ for expressing hardness.

Q7. Write formula for calculating $CaCO_3$ equivalent for a salt.

Q8. Give multiplication factors for $MgCl_2$, $CaSO_4$, $Al_2(SO4)_3$ & HCO_3^-

Q9. Determine the CaCO3 equivalent of 83 mg of $Mg(HCO_3^-)_2$

Q10. How will you remove temporary hardness of water? Write down the chemical equation also.

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21

Suggested links from NPTEL & other Platforms:

- https://nptel.ac.in/courses/105/106/105106119/
- https://www.youtube.com/watch?v=Sa0WfA9UGG0
- https://youtu.be/_srgSvci1RY
  (Video Lecture By Dr. Barkha Shrivastava)

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22

Thank You!

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